Memoirs of the Museum of Victoria 56(2):475–482 (1997) 28 February 1997
https://doi.org/10.24199/j.mmv.1997.56.41

INVERTEBRATE FAUNA OF THE TAMAR ESTUARY, NORTHERN TASMANIA

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Abstract

Smith, B.J., 1997. Invertebrate fauna of the Tamar estuary, northern Tasmania. *Memoirs of the Museum of Victoria* 56(2): 475–482.

There are very few large estuaries in southern Australia. One of the most significant is the Tamar Estuary in northern Tasmania, capable of admitting 80 000 ton ships into its lower reaches and navigable by ships of over 4000 tons to the City of Launceston more than 60 km from Bass Strait. Estuaries are the most heavily utilised and modified of all coastal habitats. The habitat range within a large estuary is wider than any other aquatic habitat, being subject to three sets of variables: habitat type (from rocky shore to soft mud), extent of tidal exposure and salinity. Thus, while the species of intertidal animals inhabiting estuaries are amongst the most tolerant of environmental change, they are also the most threatened of littoral assemblages. Although the Tamar Valley was settled by Europeans over 190 years ago and the estuary services a large city, intensive agriculture and heavy industry, the fauna still has most of the assemblages expected in a large estuary. Results of a distributional survey of the intertidal invertebrate fauna of the Tamar are presented and comparisons made with other major estuaries in southern Australia.

Introduction

All intertidal animals live in a habitat subject to two sets of environmental variables: the various substrate types and the rise and fall of the tides. The estuarine intertidal environment has a third habitat variable, salinity, in addition to these. Thus intertidal estuarine species are amongst the most tolerant of environmental fluctuations of any assemblages of animals. Many of the species of invertebrates that live in a large estuary have populations which, over a typical annual cycle, are subject to wide daily and seasonal variations in flow, salinity, suspended solid load, temperature and many other factors. The species that can tolerate such fluctuations are few in number but often have very large population densities as competitors are also few in number.

Unfortunately the geographical characteristics of large estuaries also make them very attractive for human development. Many around the world are sites for major cities, massive port construction and the development of heavy industry on flat land close to large-ship access, often with resultant massive habitat change and heightened pollution of the waterway. Large estuaries are those whose inflow rivers have large catchments and wide deep entrances that allow significant tidal inflow. They also have a significant longitudinal zone of tidal influence that allows the development of a gradual salinity gradient.

By this definition there are very few major estuaries in the southern Australian faunal zone. Virtually none of the rivers of Victoria, South Australia or the southern coast of Western Australia have the series of characteristics that would enable them to be classified as major estuaries. They mainly lack a significant longitudinal distance of tidal influence and hence a gradual salinity gradient. In most of these mainland southern rivers the zone of reduced salinity is comparatively short, only a kilometre or two at most. Tasmania has three or four estuaries which might be classified as major: Bathurst and Macquarie Harbours on the west coast, the Derwent River in the south east and the Tamar River on the north coast. Of these the Tamar is the largest and the only one with an extensive central section which is truly estuarine in character.

The Tamar is the tidal estuary of the North Esk and South Esk Rivers, which combine at the site of the City of Launceston. From here the estuary runs NNE for about 63 river km to Bass Strait. The tidal range is approximately 3 m at George Town near the mouth and 3.5 m at Launceston (Phillips, 1975; Pringle, 1982). Bottom salinity values vary in a regular manner from normal marine (about 35.3 parts per thousand) in Port Dalrymple to about 18 ppt at Dilston, to almost fresh (less than 1 ppt) at Launceston in both summer and winter (Bell, in press). The freshwater inflow from the two rivers can fluctuate widely over a year with occasional major floods.

The Tamar Valley was first settled by Europeans in 1804 and is now a major centre of population, trade and commerce with a population of over 100 000 people. A great deal of dredging, removal of hazards and other 'improvements' have been carried out over the years so that ships of over 4200 tons are able to reach Launceston, while the berths at Bell Bay in Port Dalrymple take ships of over 80 000 tons (Branagan, 1994). Heavy industry has been established along the lower reaches close to these major port facilities.

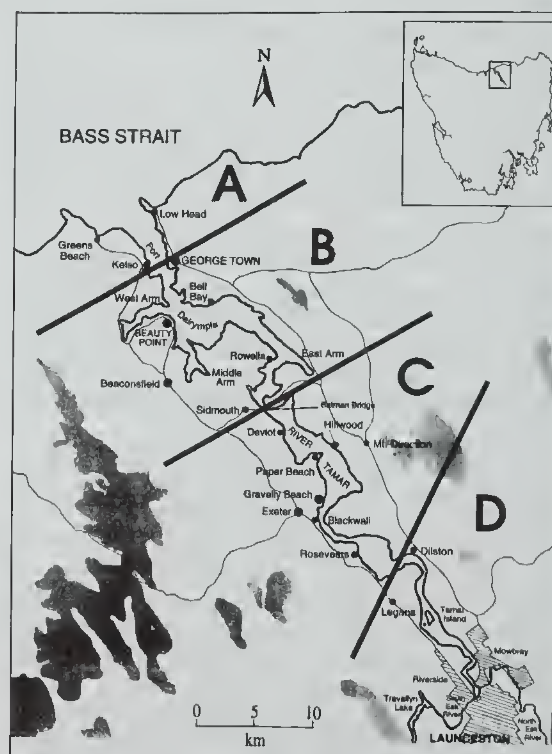
Besides all the 'river improvements' and development that have so changed the character of the estuary, two organisms introduced into the Tamar in the last 50 years, have had a profound effect on its appearance and biology. The exotic Rice-Grass, *Spartina anglica*, was introduced into the Tamar at Windermere in 1947 by the Marine Board and the Department of Agriculture to stabilise the mudflats and eventually turn them into 'useful land', and to force the stream flow into the central part of the estuary, creating a scouring effect and keeping the main channel free of mud. *Spartina anglica* now covers over 500 ha in the estuary and stretches from south of Tamar Island to north of East Arm (Phillips, 1975; Pringle, 1993).

The Pacific Oyster, *Crassostrea gigas*, was introduced into Port Sorell, northern Tasmania by CSIRO in 1953 in an attempt to start an oyster industry. It is thought that introductions from this source into the Tamar took place fairly rapidly by natural transport of planktonic larvae by coastal currents. This species is now massively established in the Tamar forming a heavy band about the mid tide level and providing hard substrate for the settlement of other animals in places where very little occurred naturally (Thomson, 1959; Coleman, 1986; Olsen, 1994). The oyster now occurs over three-quarters of the length of the estuary from George Town to Freshwater Point.

Survey of common intertidal macroinvertebrates

No comprehensive survey has ever been carried out of the invertebrate fauna of the entire estuary. A number of small, local studies have been done in specific areas of planned development but many of these have never been published. To provide some baseline data on the fauna of the whole estuary and to make an assessment of its health, a distributional survey of the common intertidal macroinvertebrates of the Tamar was carried out during 1993–1994. The area of the estuary was divided into 2 x 2 km squares and each square was visited as access permitted and observations and basic collections of specimens were made. Each square was visited at least once and several squares in critical areas were visited a number of times to cover all the main habitat types. All specimens collected were identified and incorporated into the research reference collections of the Queen Victoria Museum. The results were tabulated and an assessment made of the fauna.

From an assessment of the distribution of the intertidal invertebrates found on the survey the estuary was divided into four zones (Map 1). Zone A extended from Low Head to George Town; Zone B from George Town to the Batman Bridge; Zone C from the Batman Bridge to Dilston and Zone D from Dilston to Launceston. Zone A yielded a wide diversity of species typical of the sheltered open coast fauna found right



Map 1. Map of the Tamar Valley showing the main geographical features (the four faunal zones — A, B, C, D — are shown) (shaded areas are high ground).

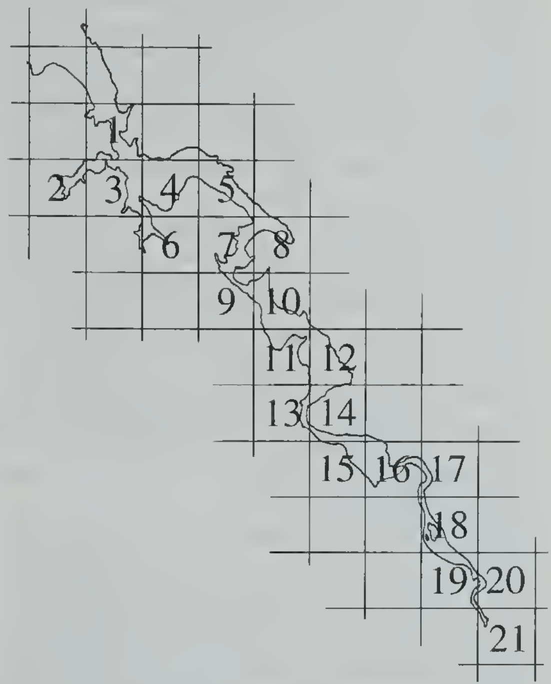
along the north coast of Tasmania and almost identical to that described for the Victorian coast by the Marine Research Group of Victoria (1984). Species that were only found in this zone in the survey are not listed in the detailed results of the survey below as they are not considered to be species inhabiting the estuary.

Species found in any of the other three zones are listed in Appendix 1. A summary of the species numbers in each major group of invertebrates is given in Table 1. Distribution maps of 28 of the commonest species are published elsewhere (Smith, 1995).

Many of the smaller or the more uncommon species are not listed here. In particular the polychaete, isopod and amiphipod species numbers are probably significantly under represented as their habitats were not thoroughly searched. Some sieving and microscope examination of debris samples was carried out but the main field technique used was hand searching and picking.

A more detailed summary of the distribution of the commoner species is given in Appendix 2. For this, data from the original 2 x 2 km squares are amalgamated into 4 x 4 km squares beginning at the Zone A/Zone B boundary. The distribution of these large squares on an outline of the Tamar is given in Map 2. Thirty-three of the larger and more common species are listed with their presence in the larger squares marked. The total number of species for each large square is given. Zone B consists of squares 1 to 8; Zone C squares 9 to 16; Zone D squares 17 to 21.

Of the 33 species considered for this analysis, Zone B has an average of 21 species per square; Zone C has 12.5 and Zone D has 3. In Zone B, square 1 is the area closest to fully marine conditions with by far the highest number of species recorded. By contrast, square 2, with only 16 species, is the at the end of West Arm, far away from the main channel. Squares 9 and 10 have the highest species count in Zone C, being the closest to Zone B. There is a significant drop in the number of species recorded in the transition between Zones C and D (squares 16 and 17).



Map 2. Map of the Tamar with the 4 x 4 km grid squares used in Appendix 2.

Discussion

The large and varied intertidal fauna found between Low Head and George Town was in every way typical of the fauna of comparable habitats anywhere along the open Bass Strait coast. After the study was completed, the ore carrier, *Iron Baron*, ran aground in July 1995 off the mouth of the Tamar, causing a major oil spill which grossly affected this fauna. Damage was caused both by the oil and by the physical and chemical means used to 'clean up' the spill from the intertidal zone. While the local damage was severe, it is anticipated that this event will have little or no long-term effects as recolonization should take place via planktonic larvae from adjacent areas within one or two seasons.

Major elements of this open coast fauna extend some distance up river beyond George Town at least into the Port Dalrymple-Bell Bay basin (Appendix — Zone B). More detailed work would reveal how much of this fauna is self-perpetuating, recruiting the next generation from within the area, and how much is accidental, developing from planktonic larvae carried into the estuary by tidal currents from breeding populations along the coast. Certainly many of the species are only found on, or close to, the main channel; the narrows between Point Effingham and Clarence Point are especially rich in open coast species. Species such as the rocky shore limpet, *Cellana tramoserica*, were found at Point Effingham but no further into the estuary. Once through these narrows the tidal current enters the broad expanse of Port Dalrymple and it can be surmised that many of the larvae of the open coast species are no longer able to find favourable settling sites.

The wide area of Port Dalrymple, with its almost full sea-water salinity and variety of habitat types, has a broad diversity of faunal assemblages, even though it also carries major port development, and the sediment may be contaminated with heavy metals from old mining tailings and the discharge of industry. The mud-dwelling species reach their largest numbers in this region of quiet sheltered waters. These include the burrowing bivalves *Spisula* (*Notospisula*) *trigonella*, *Katelysia peronii* and *Eumarcia fumigata*, with *Laternula* spp. and *Thraciopsis elongata* in the soft mud areas. These latter species were found together with a variety of polychaetes, the mud crab *Heloecius cordiformis*, and a callianassid shrimp *Callianassa ceramica*.

South of Batman Bridge the estuary becomes more estuarine in character with a lower salinity and a much simpler intertidal fauna which lacks many of the open coast species (Appendix — Zone C). This pattern is mirrored in recent work on the Foraminifera of the estuary (Bell, in press). The species that persist in this zone obviously have a wider habitat tolerance than their fully marine relatives, since they are able to live not only with greater fluctuations in salinity but also higher silt loads in the water, and a negligible input of ocean plankton carried in on tidal currents. There is still a strong tidal influence in this region but far less tidal input or flushing. Despite the conditions this zone still yielded 50 species of intertidal invertebrates (Table 1), even 25 km or more from Bass Strait.

This central part of the estuary is dominated by two introduced organisms, the Rice Grass, *Spartina anglica*, and the Pacific Oyster, *Crassostrea gigas*. The extent and effects of the *Spartina* infestation was documented recently by Pringle (1993). A species that was once widely introduced as an aid to land reclamation and prevention of coastal erosion in many parts of southern Australia and New Zealand, *Spartina* is now being viewed as an environmental problem. The Pacific Oyster has the largest biomass of any intertidal animal in the estuary. Another exotic species was recognised as a recent introduction into the estuary. The small bag mussel, *Musculista senhousia* (Benson, 1842) was recorded from the Tamar for the first time. It has been recorded as an introduction into New Zealand (Willan, 1985) and the Swan Estuary, Western Australia (Slack-Smith and Brearley, 1987). Since then it has been recorded from Port Phillip Bay (R. Burn, pers. comm.). A native of the western North Pacific, it is one of the species thought to have been introduced world-wide in ballast water. Other introduced ballast water species, such as the Northern Pacific Seastar, *Asterias amurensis*, now infesting the Derwent Estuary in southern Tasmania may establish themselves in the Tamar in the future.

South of Dilston (Appendix, Zone D) the intertidal fauna becomes extremely simple with only 11 species being found. These comprise 4 gastropods, 4 crabs, 1 shrimp, 1 bivalve and 1 worm species. Though still being fully tidal, the water has a greatly reduced salinity and a heavy silt load.

The presence of these varied faunal assemblages over the whole length of the estuary suggests that, despite all the developments and improvements carried out over the more than 190 years of European use of the river, the overall health of the river appears to be good. Other estuaries within the southern Australian faunal region have similar suites of species. The molluscs of some of the larger estuaries in south-western Australia were listed by Wells (1984) but most of these estuaries were much smaller in size, and especially in longitudinal extent, than the Tamar. The Derwent is similar in some respects to the Tamar, but is more heavily affected by discharge from the city and industry of Hobart and also has a much shorter estuarine segment where the salinity is reduced.

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Table 1. Summary of the numbers of species of intertidal macroinvertebrates collected in each of the zones of the Tamar.

Invertebrate Group	Zone B	Zone C	Zone D
Porifera	3	2	—
Cnidaria — Actinaria	1	—	—
Platyhelminthes — Polycladida	1	—	—
Bryozoa	3	1	—
Annelida — Oligochaeta	—	—	1
Annelida — Polychaeta	15	4	—
Mollusca — Polyplacophora	6	1	—
Mollusca — Bivalvia	20	7	1
Mollusca — Gastropoda	43	14	4
Crustacea — Cirripedia	7	3	—
Crustacea — Isopoda and Amphipoda	2	3	—
Crustacea — Decapoda	12	12	5
Echinodermata — Asteroidea	5	1	—
Echinodermata — Ophiuroidea	1	—	—
Chordata — Ascidiacea	3	2	—
Totals	121	50	11

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Appendix 1. List of intertidal invertebrate animals found on the Tamar Survey. The species listed here are those found south of George Town in the River Tamar. The distribution zones are as follows:
B = between George Town and the Batman Bridge; C = between the Batman Bridge; and Wndermere; D = South of Windermere.

	ZONES
PORIFERA	
Identity unknown; about 3 spp.	B, C
CNIDARIA — ACTINARIA	
Actiniidae: *Anthopleura aureoradiata*	B
PLATYHELMINTHES — POLYCLADIDA	
Leptoplanidae: *Notoplana australis*	B
BRYOZOA	
Identity unknown: about 3 spp.	B, C
ANNELIDA — OLIGOCHAETA	
Tubificidae (possibly): identity unknown	-, -, D
ANNELIDA — POLYCHAETA (family identification tentative)	
Polynoidae: polynoid sp.	B
Phyllodocidae: phyllodocid sp.	B
Syllidae: syllid sp.	B
Nereidae: nereid spp.	B, C
Glyceridae: glycerid sp.	B
Eunicidae: eunicid spp.	B, C
Orbiniidae: orbiniid sp.	B
Spionidae: spionid sp.	B
Capitellidae: capitellid sp.	B
Maldanidae: maldanid sp.	B
Terebellidae: *Amphitrite rubra*	B
Terebellidae: terebellid sp.	B
Serpulidae: *Galeolaria caespitosa*	B
MOLLUSCA — POLYPLACOPHORA	
Ischnochitonidae: *Ischnochiton (Ischnochiton) elongatus*	B
— *Ischnochiton (Ischnochiton) variegatus*	B
Chitonidae: *Sypharochiton pellisserpentis*	B, C
Cryptoplacidae: *Cryptoplax striata*	B
Acanthochitonidae: *Acanthochitona granostriata*	B
— *Acanthochitona sueurii*	B
MOLLUSCA — BIVALVIA	
Arcidae: *Barbatia (Barbatia) pistachia*	B
— *Barbatia (Barbatia) squamosa*	B
Mytilidae: *Xenostrobus inconstans*	B, C, D
— *Xenostrobus pulex*	B
— *Musculista senhousia*	B, C
Pteriidae: *Electroma georgiana*	B
Ostreidae: *Crassostrea gigas*	B, C
Lasaeidae: *Lasaea australis*	B
Mactridae: *Spisula (Notospisula) trigonella*	B
Mesodesmatidae: *Paphies (Atactodea) erycinaea*	B
Tellinidae: *Tellina (Macomona) deltoidalis*	B, C
Veneridae: *Katelysia peronii*	B, C
— *Katelysia scalarina*	B
— *Eumarcia fumigata*	B
— *Venerupis (Venerupis) anomala*	B
Hiatellidae: *Hiatella australis*	B
Teredinidae: *Bankia* spp.	B, C
Laternulidae: *Laternula tasmanica*	B
— *Laternula creccina*	B, C
Thraciidae: *Thraciopsis elongata*	B
MOLLUSCA — GASTROPODA	
Nacellidae: *Cellana tramoserica*	B
Acmaeidae: *Notoacmea flammea*	B, C
— *Notoacmea scabrilirata*	B
— *Notoacmea petterdi*	B, C
— *Collisella mixta*	B
Neritidae: *Nerita (Melanerita) atramentosa*	B
Fissurellidae: *Montfortula rugosa*	B
Turbinidae: *Astralium (Micrastraea) aurea*	B
— *Turbo (Subninella) undulata*	B
Trochidae: *Monodonta (Austrocochlea) constricta*	B
— *Diloma (Fractarmilla) concamerata*	B, C
— *Diloma (Chlorodiloma) adelaidae*	B
— *Cantharidus (Phasianotrochus) irisodontes*	B
— *Echelus (Herpetopoma) aspersa*	B
— *Clanculus (Isoclanculus) aloysii*	B
Cerithiidae: *Bittium granarum*	B, C
Batillariidae: *Batillaria (Zeacumantus) diemenensis*	B, C
— *Batillaria (Velacumantus) australis*	B, C
Campanilidae: *Campanile (Hypotrochus) monachus*	B
Littorinidae: *Littorina (Austrolittorina) unifasciata*	B
— *Bembicium melanostoma*	B, C
Hydrobiidae: *Tatea rufilabris*	B, C, D
— *Potamopyrgus antipodarum*	-, -, D
Assimineidae: *Assiminea (Metassiminea) buccinoides*	B, C, D
Hydrococcidae: *Hydrococcus brazieri*	B, C
Naticidae: *Polinices (Conuber) conicus*	B
Muricidae: *Bedeva paivae*	B
— *Lepsiella vinosa*	B

— *Thais orbita*	B
Buccinidae: *Cominella lineolata*	B
— *Nassarius (Niotha) pauperatus*	B, C
— *Nassarius (Plicarcularis) burchardi*	B
— *Nassarius (Zeuxis) pyrrhus*	B, C
— *Pleuroploca australasia*	B
Columebellidae: *Mitrella (Dentimitrella)* sp.	B
Conidae: *Conus (Floraconus) anemonae*	B
Philinidae: *Philine angasi*	B
Pleurobranchidae: *Pleurobranchaea maculata*	B
Dorididae: unknown sp.	B
Onchidiidae: *Onchidella patelloides*	B
Ellobiidae: *Ophicardelus ornatus*	B, C, D
Siphonariidae: *Siphonaria (Hubendickula) diemenensis*	B
Amphibolidae: *Salinator fragilis*	B, C, D
CRUSTACEA — CIRRIPEDIA	
Iblidae: *Ibla quadrivalvis*	B
Balanidae: *Elminius covertus*	B, C
— *Elminius modestus*	B, C
— *Balanus variegatus*	B, C
— *Epopella simplex*	B
Chthamalidae: *Chthamalus antennatus*	B
Tetraclitidae: *Tetraclitella purpurascens*	B
CRUSTACEA — ISOPODA & AMPHIPODA	
Ligiidae: *Ligia australiensis*	B, C
Sphaeromatidae: *Sphaeroma quoyanum*	-, C
Talitridae: *Orchestia* sp.	B, C
CRUSTACEA — DECAPODA	
Callianassidae: *Callianassa ceramica*	B, C
Palaemonidae: *Palaemon* sp.	B, C
— *Palaemonetes* sp.	-, C, D
— *Leander* sp.	B
Grapsidae: *Paragrapsus gaimardii*	B, C, D
— *Paragrapsus quadridentatus*	B, C
— *Cyclograpsus granulosus*	B, C
— *Helograpsus haswellianus*	B, C, D
— *Brachynotus spinosus*	B, C
Ocypodidae: *Macrophthalmus latifrons*	B, C, D
— *Heloecius cordiformis*	B, C
Hymenosomatidae: *Amarinus laevis*	B, C, D
Mictyridae: *Mictyris platycheles*	B, C
ECHINODERMATA — ASTEROIDEA	
Goniasteridae: *Tosia australis*	B
Asterinidae: *Patiriella exigua*	B, C
Asteriidae: *Allostichaster polyplax*	B
— *Uniophora granifera*	B
— *Coscinasterias calamaria*	B
ECHINODERMATA — OPHIUROIDEA	
Amphiuridae: *Ophiocentrus pilosus*	B
CHORDATA — ASCIDIACEA	
Identity unknown: about 3 spp.	B, C

(NOTE: Recently the gastropod *Austrocochlea constricta* was split into three species (Parsons and Ward, 1994). While it is probable that all three species are present in the Tamar, no attempt has been made to follow this study at present.)

Appendix 2. Table showing the distribution of the common intertidal invertebrates of the Tamar. For the position of the large squares see Map 2

Large Square Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
PLATYHELMINTHES																					
Notoplana australis	X		X		X	X		X													
ANNELIDA - POLYCHAETA																					
Galeolaria caespitosa	X		X	X	X	X															
MOLLUSCA - POLYPLACOPHORA																					
Syph. pellisserpentis	X	X	X	X	X	X	X	X	X	X	X		X								
MOLLUSCA - BIVALVIA																					
Xeno. inconstans	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X				
Musc. senhousia			X			X				X	X			X							
Crassostrea gigas	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						
Lasaea australis	X		X	X	X		X	X													
Spis. (N.) trigonella						X		X	X			X	X		X						
Latemula spp.	X	X	X		X		X	X													
MOLLUSCA - GASTROPODA																					
Noto. flammea	X		X	X	X	X			X												
Nerita atramentosa	X		X	X	X			X													
Montfortula rugosa	X			X																	
Monodonta constricta	X	X	X	X		X															
Littorina unifasciata	X			X	X		X														
Bemb. melanostoma	X	X	X	X		X	X	X	X	X	X	X	X	X	X						
Tatea rufilabris	X	X				X	X	X		X	X	X	X	X	X	X	X	X			
Pot. antipodarum																		X	X	X	X
Ass. buccinoides	X	X				X		X		X			X	X	X	X	X				
Lepsiella vinosa	X			X		X	X														
Cominella lineolata	X		X	X			X														
Nass. pauperatus	X	X	X	X	X	X	X	X	X	X	X	X	X	X							
Onch. patelloides	X		X	X	X	X	X														
Ophicardelus ornatus	X	X		X	X	X	X	X	X	X	X	X			X	X					
Siph. diemenensis	X		X	X	X	X	X														
Salinator fragilis	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X			
CRUSTACEA - CIRRIPEDIA																					
Elminius covertus	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					
CRUSTACEA - DECAPODA																					
Para. gaimardii	X	X	X			X	X	X	X	X	X		X	X	X	X			X		
Cyclo. granulosus	X		X	X	X	X	X		X	X											
Helo. haswellianus	X	X				X	X	X	X	X				X	X	X					
Macr. latifrons	X	X	X		X			X			X		X	X	X	X					
Heleo. cordiformis	X	X	X		X		X	X	X	X			X								
Amarinus laevis						X							X	X	X	X	X	X	X		X
ECHINODERMATA - ASTEROIDEA																					
Patirella exigua	X		X	X	X	X	X		X												
TOTAL	29	16	23	20	19	24	21	19	15	15	12	9	13	13	13	10	5	4	3	1	2